ANL/EVS/AGEM/TR-08-04

Argonne NATIONAL LABORATORY

November 2007 Monitoring Results for Barnes, Kansas

Environmental Science Division

USDA United States Department of Agriculture

Work sponsored by Commodity Credit Corporation, United States Department of Agriculture

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by
Applied Geosciences and Environmental Management Section
Environmental Science Division, Argonne National Laboratory

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Notation

AGEM	Applied Geosciences and Environmental Management
AMSL	above mean sea level
BGL	below ground level
°C	degree(s) Celsius
CCC	Commodity Credit Corporation
COC	chain of custody
EPA	U.S. Environmental Protection Agency
ft	foot (feet)
gal	gallon(s)
KDHE	Kansas Department of Health and Environment
µg/L	microgram(s) per liter
µS/cm	microsiemen(s) per centimeter
min	minute
TOC	top of casing
USDA	U.S. Department of Agriculture
VOC	volatile organic compound

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1 Introduction and Background

The Commodity Credit Corporation of the U.S. Department of Agriculture (CCC/USDA) formerly operated a grain storage facility (during most of the interval 1949-1974) at Barnes, Kansas. Carbon tetrachloride contamination was initially detected in 1986 in the town's public water supply wells. In 2006-2007, the CCC/USDA conducted a comprehensive targeted investigation at and near its former property in Barnes to investigate this contamination.

In November 2007, the CCC/USDA began quarterly groundwater monitoring at Barnes. The monitoring is being conducted on behalf of the CCC/USDA by Argonne National Laboratory, in accord with the recommendations made in the report for the 2006-2007 targeted investigation (Argonne 2007). The objective is to monitor the carbon tetrachloride contamination identified in the groundwater at Barnes. The sampling is presently conducted in a network of 28 individual monitoring wells at 19 distinct locations, 2 public water supply wells, and 1 private well (Figure 1.1).

The results of the 2006-2007 targeted investigation demonstrated the presence of carbon tetrachloride contamination at levels slightly exceeding the Kansas Department of Health and Environment (KDHE) Tier 2 risk-based screening level of 5.0 µg/L for this compound, in a plume that appears to extend from the former CCC/USDA property northwestward, toward the Barnes public water supply wells. Information obtained during the 2006-2007 investigation indicates that at least one other potential source might have contributed to the groundwater contaminant plume (Argonne 2007). The present report presents the results of the November 2007 sampling event that followed the targeted investigation.

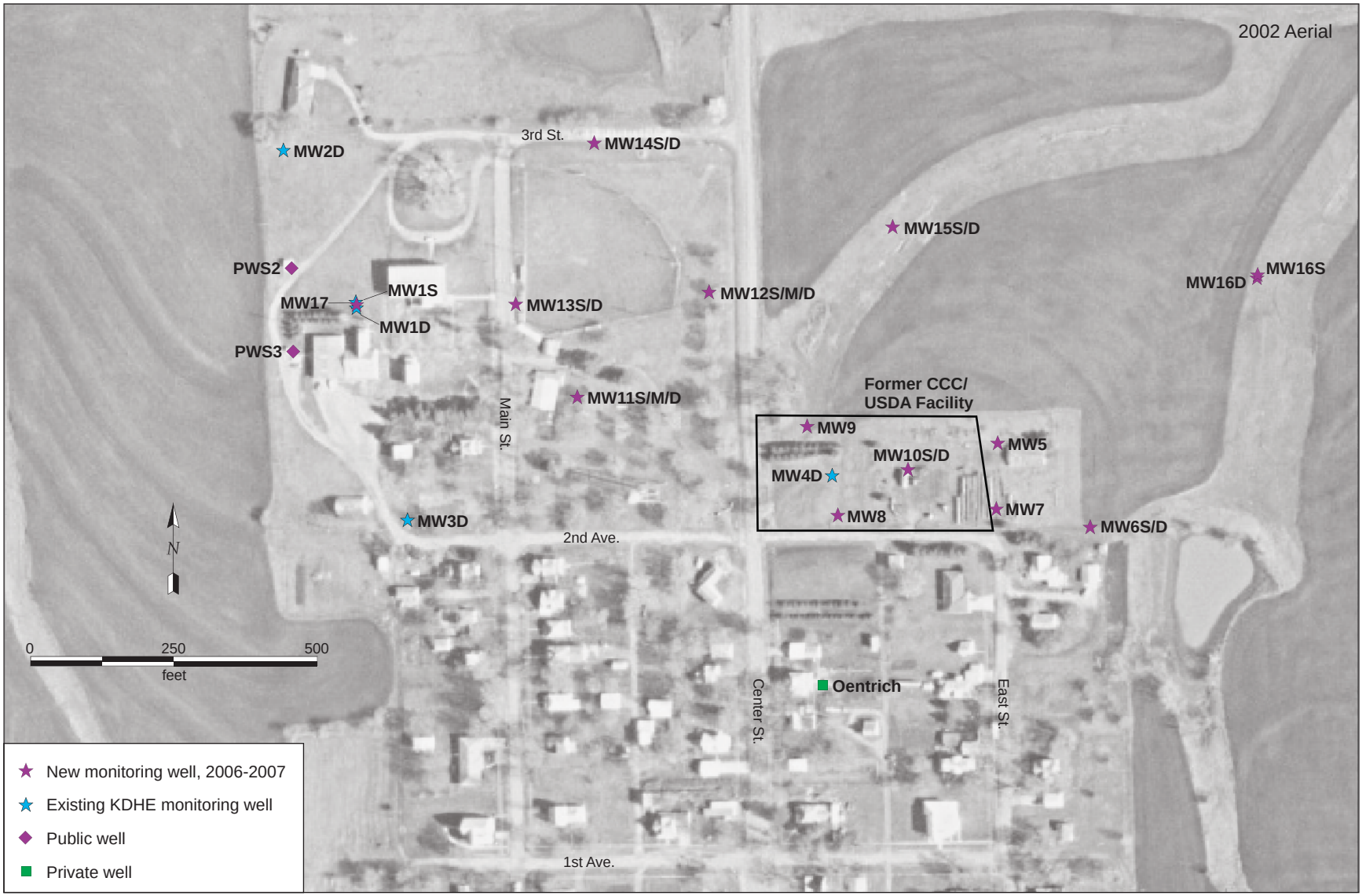


FIGURE 1.1 Groundwater sampling locations at Barnes, as of November 2007.

2 Sampling and Analysis Activities

2.1 Measurement of Groundwater Levels

In conjunction with the groundwater sampling event reported here, groundwater levels were measured manually on November 18-19, 2007, in 28 monitoring wells (MW1S, MW1D, MW2D, MW3D, MW4D, MW5, MW6S, MW6D, MW7, MW8, MW9, MW10S, MW10D, MW11S, MW11M, MW11D, MW12S, MW12M, MW12D, MW13S, MW13D, MW14S, MW14D, MW15S, MW15D, MW16S, MW16D, MW17). Before these wells were purged in preparation for sampling, a water level indicator was used to measure the depth to groundwater and the total depth of each well, to within 0.01 ft, from the top of the well casing. Monitoring wells MW1S and MW12S were measured but were found to be dry and consequently could not be sampled. Two public water supply wells (PWS2 and PWS3) and 1 private well (Oentrich) were sampled but not measured. All of the well locations are shown in Figure 1.1.

During the present monitoring period, another set of manual measurements of water levels was made in all available wells on June 9, 2007.

In addition to the manual water level measurements, data recorders have been gathering long-term data on the groundwater elevation and gradient at monitoring wells MW1D, MW2D, MW3D, MW4D, MW7, MW9, MW14D, MW15D, and MW16D and at the Oentrich private well (Figure 2.1). The data loggers record water levels continuously at 30-min intervals. Additional sets of manual water level measurements were made in these wells equipped with data loggers on September 7, 2007, and December 19, 2007.

The groundwater level data are presented and discussed in Section 3.1.

2.2 Monitoring Well Sampling and Analyses

After measurement of water levels on November 18-19, 2007, and before sampling, the wells were purged of a minimum three well volumes or until they were dry. Field measurements of temperature, pH, and conductivity were taken during purging until the measurements stabilized. All sampling and field analyses were performed in accord with procedures in the *Master Work Plan* (Argonne 2002). The sequence of activities during the November well

sampling event is summarized in Appendix A, Table A.1. The field measurements are in Appendix A, Table A.2.

Groundwater samples designated for analyses for volatile organic compounds (VOCs) were collected in appropriate laboratory containers, labeled, packaged, and chilled to 4°C by placement in ice-filled coolers. The samples were shipped via an overnight delivery service to the Applied Geosciences and Environmental Management (AGEM) Laboratory at Argonne for VOCs analyses with U.S. Environmental Protection Agency (EPA) Method 524.2 (EPA 1995). Aliquots of selected samples (chosen in the field) were also shipped to Envirosystems, Inc., Columbia, Maryland, for verification VOCs analyses according to EPA Contract Laboratory Program protocols.

The analytical results are presented and discussed in Section 3.2.

2.3 Handling and Disposal of Investigation-Derived Waste

Purge water generated as potentially contaminated investigation-derived waste was containerized on-site in 55-gal drums. The accumulated purge water was sampled and analyzed for VOCs (including ethylene dibromide) and was found to contain no detectable concentration of either carbon tetrachloride or chloroform. Nitrate was present at 2.8 mg/L. The water was disposed of at the Sabetha, Kansas, publicly owned treatment works on December 14, 2007 (Sabetha 2007).

2.4 Quality Control for Sample Collection, Handling, and Analysis

Quality assurance/quality control procedures followed during the November 2007 monitoring event are described in detail in the *Master Work Plan* (Argonne 2002). The results are summarized as follows:

- Sample collection and handling activities were monitored by the documentation of samples as they were collected and the use of chain-of-custody forms and custody seals to ensure sample integrity during handling and shipment.

- Samples designated for VOCs analyses were received with custody seals intact and at the appropriate preservation temperature. All samples sent to the AGEM Laboratory were analyzed within the required holding times.

- Quality control samples collected to monitor sample-handling activities (trip blanks) and method blanks analyzed with the samples to monitor analytical methodologies were all free of carbon tetrachloride and chloroform contamination.

- Groundwater samples were analyzed for VOCs at the AGEM Laboratory with the purge-and-trap method on a gas chromatograph-mass spectrometer system. Calibration checks analyzed with each sample delivery group were required to be within ±20% of the standard. Surrogate standard determinations performed on samples and blanks were within the specified range of 80-120% for all samples, in either the initial analysis or a successful reanalysis.

- In accordance with the procedures defined in the *Master Work Plan* (Argonne 2002), three groundwater samples were submitted to a second laboratory (Envirosystems) for verification analysis according to the protocols of the EPA's Contract Laboratory Program. The Envirosystems laboratory failed to analyze the samples. Documentation is in Appendix B.

- Results from the AGEM Laboratory for dual analyses of the groundwater samples are in Appendix C, Table C.1. The results of the dual analyses compare well, indicating consistency in the sampling and analytical methodologies.

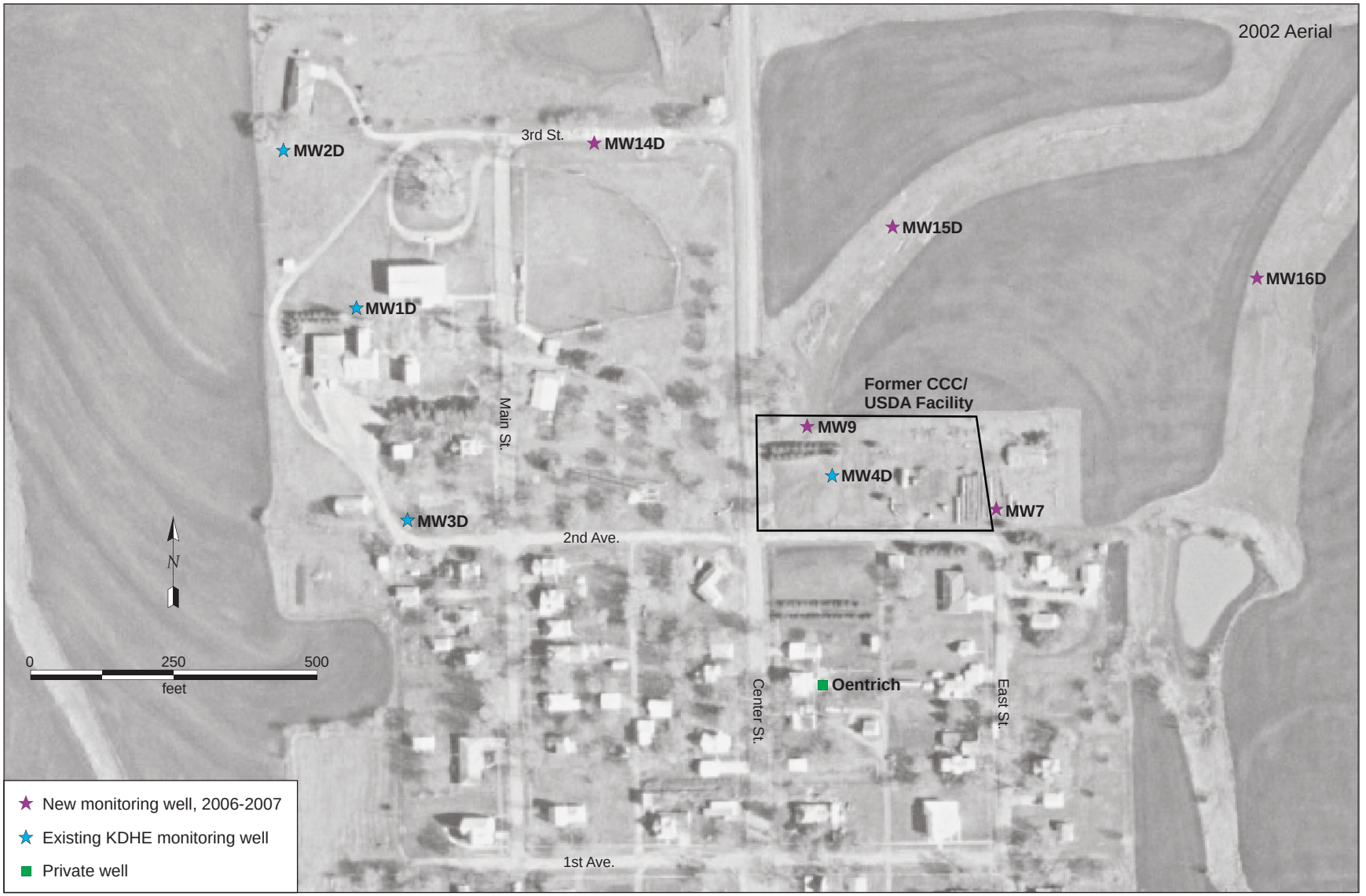


FIGURE 2.1 Wells at Barnes equipped with data loggers for water level monitoring, as of November 2007.

3 Results and Discussion

3.1 Groundwater Level Data

The results of manual water level measurements in May-December 2007 are in Table 3.1. The tables for Section 3 are grouped at the end of the section's text, before the figures.

The potentiometric surface at Barnes is depicted extensively in the targeted investigation report (Figure 4.7 in Argonne 2007). The recent results (Table 3.1) are consistent with the previous measurements, indicating an apparent groundwater flow direction toward the northwest, toward the public water supply wells. The results of the 2006-2007 targeted investigation (Argonne 2007) indicated that operation of the public water supply wells strongly influences the groundwater flow direction.

The hydrographs in Figure 3.1 summarize data for the period May 1, 2007, through December 19, 2007, from the recording transducers installed for long-term water level monitoring in wells MW1D, MW2D, MW3D, MW4D, MW7, MW9, MW14D, MW15D, MW16D, and the Oentrich well. (The well locations are shown in Figure 2.1.) The patterns in Figure 3.1 are similar to previous data (Figure 4.6 in Argonne 2007). The hydrographs show responses to pumping of the public water supply wells that are characterized by drawdowns of as much as 2 ft during pumping, with almost immediate rebound when pumping stops. The most prominent drawdowns are consistently observed in wells MW1D and MW2D, which are the closest monitoring points to the public wells. The hydrographs indicate an overall rise in water levels in June and July 2007, followed by a decline in subsequent months.

After the transducer in well MW15D was installed on May 1, 2007, it recorded responses consistent with those for the other monitoring wells until September 7, 2007. At that time, its responses became erratic and no longer correlated with those for the other wells. Consequently, the data for well MW15D recorded after September 7, 2007, are considered suspect and are not shown in Figure 3.1. The recorder will be reprogrammed or replaced.

3.2 Analytical Results for Volatile Organic Compounds in Groundwater Samples

The analytical data for VOCs in the groundwater samples collected in November 2007 are in Table 3.2, together with data for the previous sampling events conducted at Barnes. The lateral distribution of carbon tetrachloride in groundwater in the November 2007 sampling event is illustrated in Figure 3.2. The overall pattern is similar to that observed in the 2006-2007 targeted investigation (Figure 3.3 [results for April 2007 and November 2007]).

Carbon tetrachloride was detected in November 2007 in 19 of the 29 groundwater samples collected (at 13 of the 19) distinct monitoring locations; Figure 3.2 and Table 3.2). Carbon tetrachloride concentrations ranged from 0.3 J µg/L (at MW6S) to a maximum of 23 µg/L (at MW8). The concentrations of carbon tetrachloride in 8 of the 29 groundwater samples were above the regulatory level of 5.0 µg/L.

Chloroform concentrations ranging from 0.2 J µg/L (at MW13D) to 5.1 µg/L (at MW12M) were detected in 10 of the 29 groundwater samples (at 8 of the 19) distinct sampling locations; Table 3.2). Chloroform occurred in association with the more elevated carbon tetrachloride levels identified at MW4D, MW8, MW9, MW10S, MW10D, MW12M, MW13S, MW13D, and MW15S.

The present results indicate that carbon tetrachloride levels measured in November 2007 at sampling locations *on the former CCC/USDA property* had declined (MW4D, MW10S) or risen slightly (MW8, MW9, MW10D) since the previous sampling event. *Outside the former CCC/USDA property*, the carbon tetrachloride concentrations declined (MW1D, MW11D, MW12M, MW13S, MW14D), increased slightly (MW6D, MW7, MW11M, MW12D, MW13D, MW14S, MW15S, Oentrich), or remained unchanged (MW2D, MW3D, MW5, MW11S, MW15D, MW16S, MW16D, MW17).

The lateral distribution of the contaminant in groundwater was similar to the distribution observed previously (Figure 4.9 in Argonne 2007). From April 2007 to November 2007, the carbon tetrachloride concentration detected in sentinel well MW15S increased from 1.5 µg/L to 8.7 µg/L. In the other sentinel wells (as defined in Section 5.1 of Argonne 2007), the carbon tetrachloride decreased (MW14D), remained the same (MW15D, MW16S, MW17), or increased by 0.5 µg/L or less (MW6D, MW14S). A trace level of carbon tetrachloride was detected in monitoring well MW6S, which was dry and could not be sampled in April 2007.

TABLE 3.1 Hand-measured water levels at Barnes, May 2007 to December 2007.

Well	Reference Elevation (ft AMSL)	Water Level Depth (feet below top of casing) on Date Indicated									
		5/10/07		6/9/07		9/7/07		11/18/07 - 11/19/07		12/19/07	
		Time	Depth	Time	Depth	Time	Depth	Day, Time	Depth	Time	Depth
MW1S	1351.58			11:48	Dry			11/18, 16:45	Dry		
MW1D	1351.33	14:03	130.63	11:42	129.72	11:31	123.81	11/18, 16:40	124.89	10:53	125.54
MW2D	1348.85	14:45	128.32	12:01	127.57	11:12	121.56	11/18, 17:10	122.56	11:42	123.20
MW3D	1345.99	13:31	125.03	11:34	123.29	11:43	118.27	11/19,09:00	126.25	10:13	120.09
MW4D	1326.32	16:30	105.33	10:01	103.30	9:04	99.86	11/19, 08:55	101.39	14:56	100.54
MW5	1327.20			09:40	104.69			11/19, 09:15	102.78		
MW6S	1323.13			09:04	96.03			11/19, 09:30	96.10		
MW6D	1323.15			09:05	100.35			11/19, 09:35	98.50		
MW7	1329.91	16:06	109.24	09:35	107.15	9:20	103.63	11/19, 13:10	105.50	14:35	104.48
MW8	1330.06			10:08	107.02			11/19, 10:40	105.17		
MW9	1321.86	15:08	101.04	10:33	99.01	10:42	94.95	11/19, 13:05	97.20	13:17	96.25
Oentrich[a]	1336.93	16:59	115.70	10:14	113.74	12:15	109.74	11/19, 12:10	NM[b]	15:27	116.55
MW10S	1331.33			09:48	77.20			11/19, 15:00	77.81		
MW10D	1331.33			09:50	108.61			11/19, 15:05	106.22		
MW11S	1336.58			11:19	22.95			11/19, 11:30	29.20		
MW11M	1336.51			11:21	84.91			11/19, 11:35	82.33		
MW11D	1336.53			11:23	113.76			11/19, 12:00	112.46		
MW12S	1327.46			10:43	51.73			11/18, 13:15	Dry		
MW12M	1327.46			10:41	75.92			11/19, 14:10	74.50		
MW12D	1327.52			10:45	105.62			11/18, 13:30	102.00		
MW13S	1342.36			11:13	94.70			11/19, 14:00	92.23		
MW13D	1342.37			11:08	119.73			11/19, 12:50	117.83		
MW14S	1332.69			10:59	111.28			11/18, 14:55	106.75		
MW14D	1332.74	14:55	112.33	10:55	111.20	10:56	105.81	11/18, 15:38	107.10	12:07	107.23
MW15S	1309.34			10:28	87.39			11/18, 17:37	84.33		
MW15D	1309.29	15:34	84.40	10:24	80.72	10:19	77.87	11/18, 16:00	70.20	12:56	80.84
MW16S	1299.47			09:18	77.22			11/19, 09:40	75.30		
MW16D	1299.52	15:54	77.63	09:20	75.74	10:02	73.67	11/19, 09:45	74.50	14:53	74.62
MW17	1351.77			11:50	104.62			11/19, 08:02	102.68		

[a] The Oentrich well water level is measured from the concrete at the top of the well vault. The values shown have been corrected by 5.5 ft to give the measured depth from the top of the casing.

[b] NM, not measured. No access to wellhead.

TABLE 3.2 Analytical results from the AGEM Laboratory for volatile organic compounds in groundwater samples collected at Barnes, July 2006 to November 2007.

Well	Screen Interval (ft BGL)	Sample	Sample Date	Concentration (µg/L) Carbon Tetrachloride	Chloroform	Methylene Chloride
Existing KDHE monitoring wells						
MW1S	13.3-23.3	Not sampled (well dry)	7/19/06	–	–	–
		Not sampled (well dry)	4/4/07	–	–	–
		Not sampled (well dry)	11/18/07	–	–	–
MW1D	139.85-159.4	BAMW1D-W-21688	7/19/06	1.0	ND[a]	ND
		BAMW1D-W-22565	4/4/07	1.2	ND	ND
		BAMW1D-W-22593	11/18/07	ND	ND	ND
MW2D	133.26-152-93	BAMW2D-W-21687	7/19/06	ND	ND	ND
		BAMW2D-W-22564	4/4/07	ND	ND	ND
		BAMW2D-W-22594	11/18/07	ND	ND	ND
MW3D	133.02-152.73	BAMW3D-W-21686	7/19/06	ND	ND	ND
		BAMW3D-W-22567	4/4/07	ND	ND	ND
		BAMW3D-W-22595	11/19/07	ND	ND	ND
MW4D	98.38-118.22	BAMW4D-W-21690	7/20/06	2.1	ND	ND
		BAMW4D-W-22583	4/6/07	3.5	0.1 J[b]	ND
		BAMW4D-W-22596	11/19/07	1.7	0.4 J	ND
CCC/USDA wells installed during the 2006-2007 investigation						
MW5	110-120	BAMW5-W-22589	4/6/07	0.6 J	ND	ND
		BAMW5-W-22597	11/19/07	0.6 J	ND	ND
MW6S	90.5-100.5	Not sampled (well dry)	4/4/07	–	–	–
		BAMW6S-W-22598	11/19/07	0.3 J	ND	ND
MW6D	105-115	BAMW6D-W-22573	4/5/07	ND	ND	ND
		BAMW6D-W-22599	11/19/07	0.5 J	ND	ND
MW7	116-126	BAMW7-W-22588	4/6/07	1.0	ND	ND
		BAMW7-W-22600	11/19/07	2.6	ND	ND
MW8	110-120	BAMW8-W-22584	4/6/07	14	0.7 J	ND
		BAMW8-W-22601	11/19/07	23	0.6 J	ND
MW9	100-110	BAMW9-W-22582	4/5/07	1.0	ND	ND
		BAMW9-W-22602	11/19/07	7.7	0.6 J	ND
MW10S	93-103	BAMW10S-W-22586	4/6/07	20	1.4	ND
		BAMW10S-W-22603	11/19/07	11	0.7 J	ND
MW10D	115-125	BAMW10D-W-22585	4/6/07	2.4	0.2 J	ND
		BAMW10D-W-22604	11/19/07	6.3	0.5 J	ND
MW11S	40-50	BAMW11S-W-22570	4/4/07	ND	1.1	ND
		BAMW11S-W-22605	11/19/07	ND	0.6 J	ND

TABLE 3.2 (Cont.)

Well	Screen Interval (ft BGL)	Sample	Sample Date	Concentration (µg/L) Carbon Tetrachloride	Chloroform	Methylene Chloride
CCC/USDA wells installed during the 2006-2007 investigation (cont.)						
MW11M	90-100	BAMW11M-W-22572	4/5/07	ND	ND	ND
		BAMW11M-W-22606	11/19/07	3.7	ND	ND
MW11D	125-135	BAMW11D-W-22571	4/4/07	1.1	ND	ND
		BAMW11D-W-22607	11/19/07	0.8 J	ND	ND
MW12S	43-53	Not sampled (well dry)	4/5/07	–	–	–
		Not sampled (well dry)	11/19/07	–	–	–
MW12M	90-100	BAMW12M-W-22580	4/5/07	20	4.2	ND
		BAMW12M-W-22609	11/19/07	18	5.1	ND
MW12D	115-125	BAMW12D-W-22576	4/5/07	0.6 J	ND	ND
		BAMW12D-W-22610	11/18/07	1.6	ND	ND
MW13S	112-122	BAMW13S-W-22575	4/5/07	21	1.6	ND
		BAMW13S-W-22611	11/19/07	17	1.8	ND
MW13D	127-137	BAMW13D-W-22574	4/5/07	3.5	0.4 J	ND
		BAMW13D-W-22612	11/19/07	5.9	0.2 J	ND
MW14S	108-118	BAMW14S-W-22569	4/4/07	0.9 J	ND	ND
		BAMW14S-W-22613	11/18/07	1.2	ND	ND
MW14D	123-133	BAMW14D-W-22568	4/4/07	1.2	ND	ND
		BAMW14D-W-22614	11/18/07	0.6 J	ND	ND
MW15S	88-98	BAMW15S-W-22560	4/4/07	1.5	ND	ND
		BAMW15S-W-22615	11/18/07	8.7	0.4 J	ND
MW15D	105-115	BAMW15D-W-22561	4/4/07	ND	ND	ND
		BAMW15D-W-22616	11/18/07	ND	ND	ND
MW16S	76-86	BAMW16S-W-22563	4/4/07	ND	ND	ND
		BAMW16S-W-22617	11/19/07	ND	ND	ND
MW16D	90-100	BAMW16D-W-22562	4/4/07	ND	ND	ND
		BAMW16D-W-22618	11/19/07	ND	ND	ND
MW17	120-130	BAMW17D-W-22566	4/4/07	ND	ND	ND
		BAMW17D-W-22619	11/19/07	ND	ND	ND
Private wells						
Oentrich	150	BAOENT-W-21693	7/20/06	0.3 J	ND	ND
		BAOENT-W-21713	8/2/06	0.6 J	ND	ND
		BAOENTRICH-W-22579	4/5/07	0.6 J	ND	ND
		BAOENTRICH-W-22622	11/19/07	0.8 J	ND	ND
Sedivy	138	BACW-W-21849	8/22/06	ND	ND	ND
		BASED2-W-21913	9/13/06	ND	ND	ND

TABLE 3.2 (Cont.)

Well	Screen Interval (ft BGL)	Sample	Sample Date	Concentration (µg/L) Carbon Tetrachloride	Chloroform	Methylene Chloride
Private wells (cont.)						
Sedivy1	90	Not sampled (well dry)	9/13/06	–	–	–
Public water supply wells						
PWS2	155	BAPWS2-W-22510	3/9/07	ND	ND	ND
		BAPW2-W-22578	4/5/07	ND	ND	ND
		BAPW2-W-22620	11/20/07	ND	ND	ND
PWS3	160	BAPWS3-W-22511	3/9/07	0.2 J	ND	ND
		BAPW3-W-22577	4/5/07	ND	ND	ND
		BAPW3-W-22621	11/20/07	ND	ND	ND

[a] ND, contaminant not detected at an instrument detection limit of 0.1 µg/L.

[b] Qualifier J indicates an estimated concentration below the purge-and-trap method quantitation limit of 1.0 µg/L.

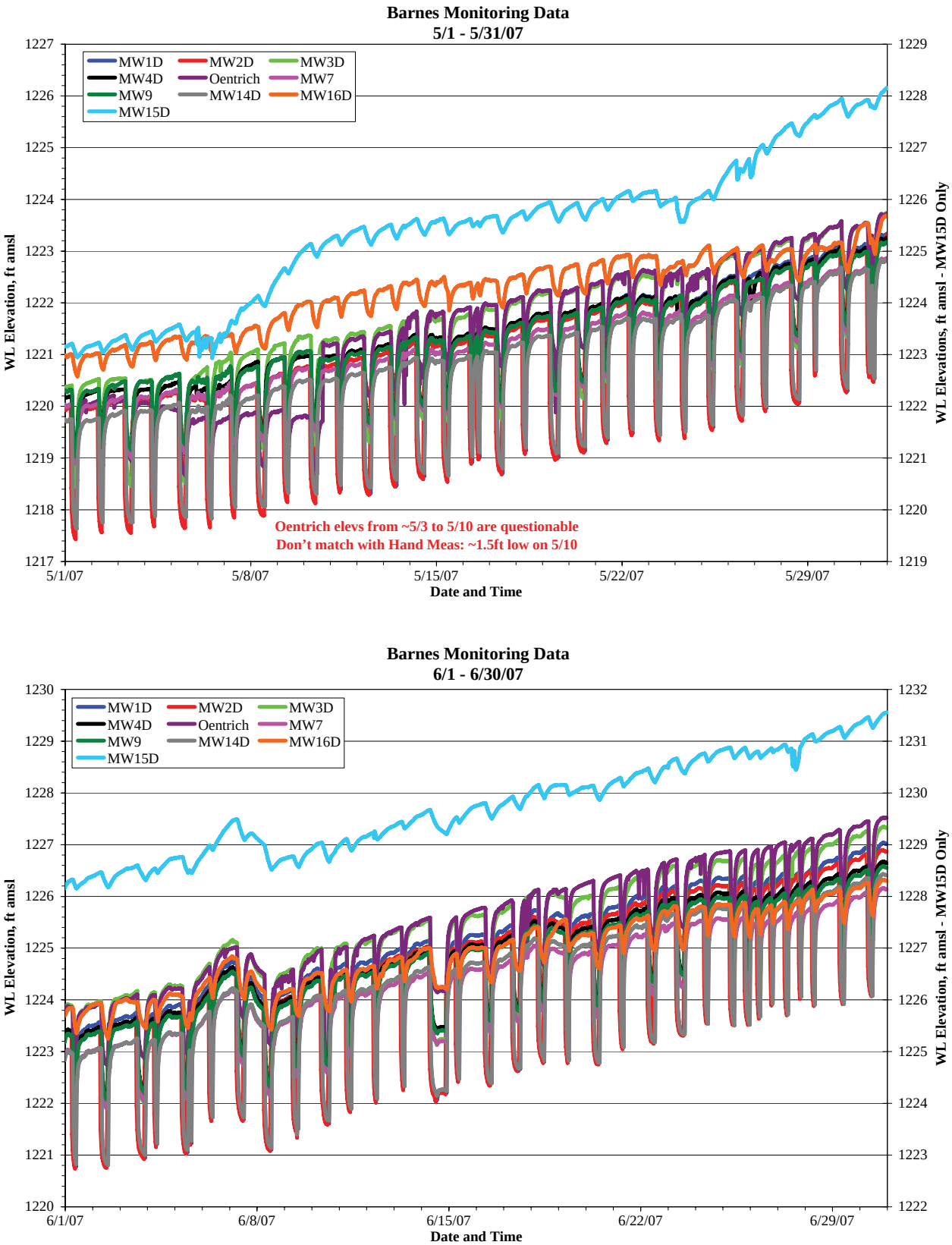
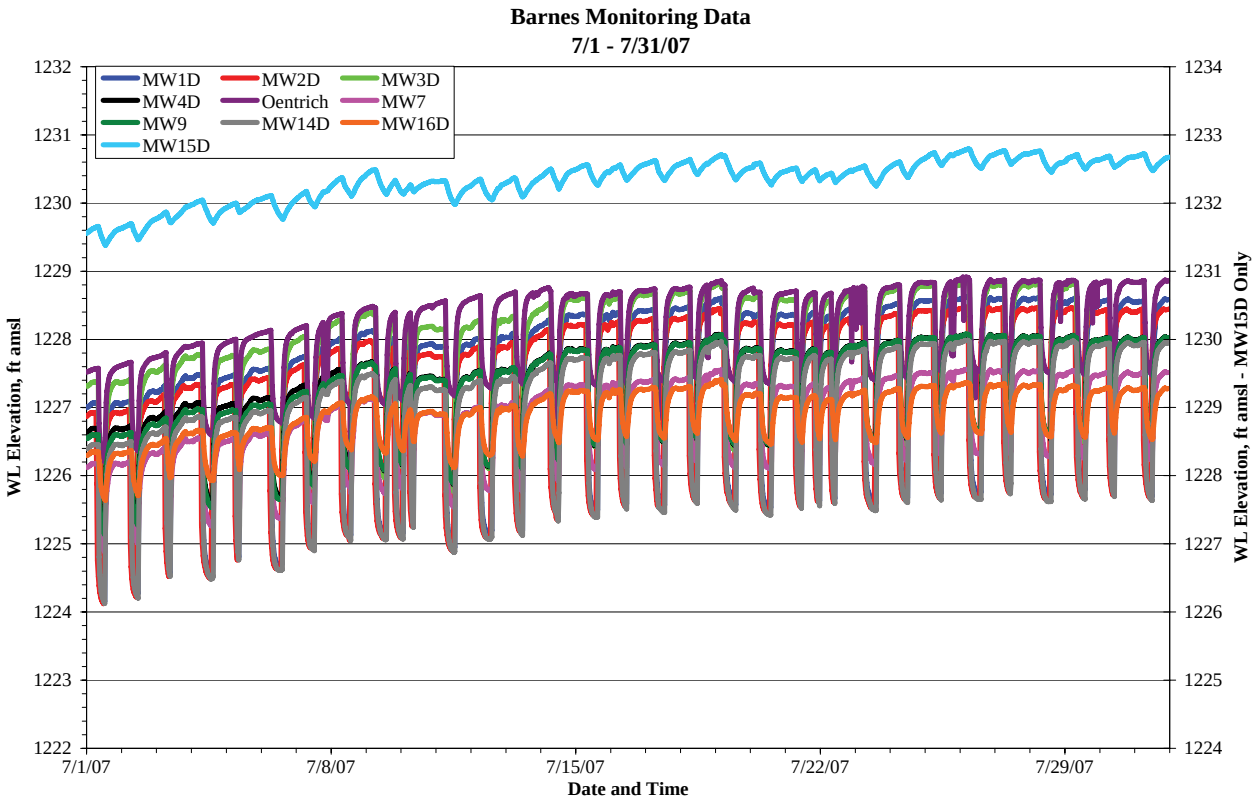


FIGURE 3.1 Hydrographs summarizing monthly results of long-term water level monitoring in wells at Barnes, May 2007 to December 2007.



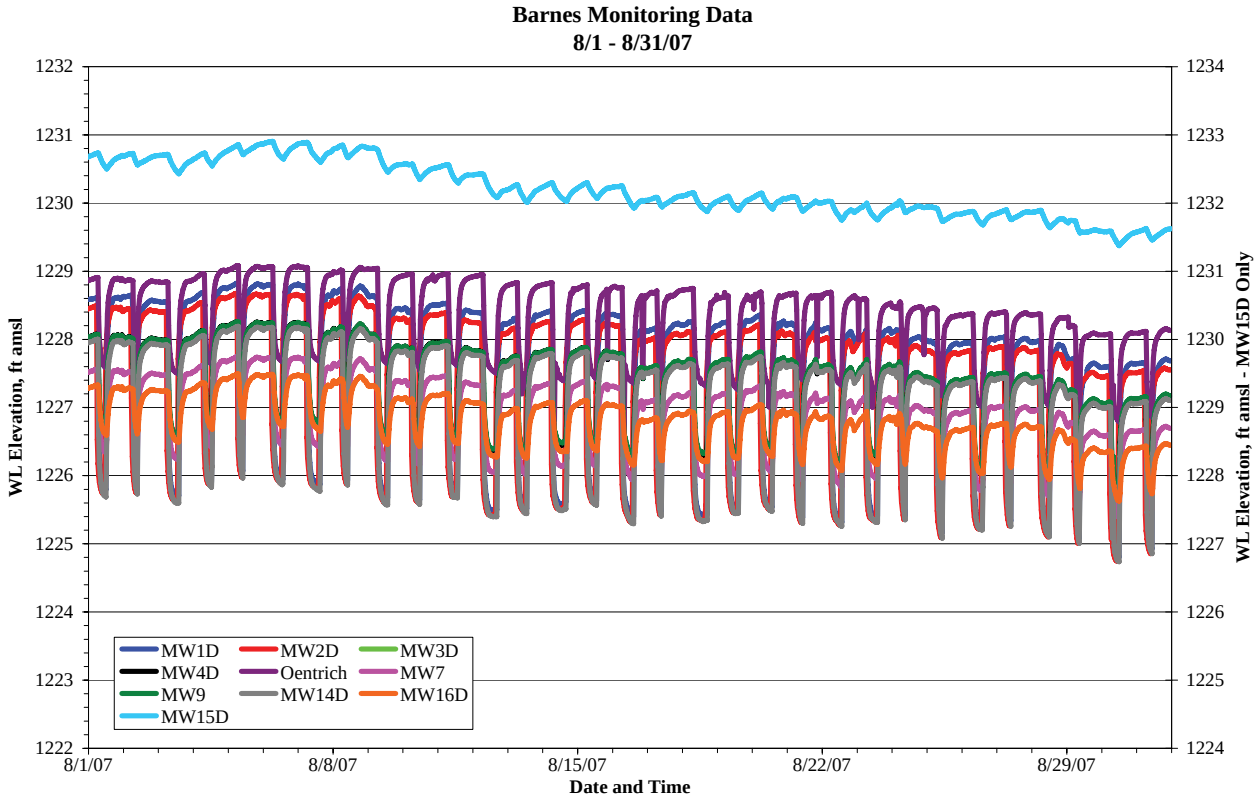
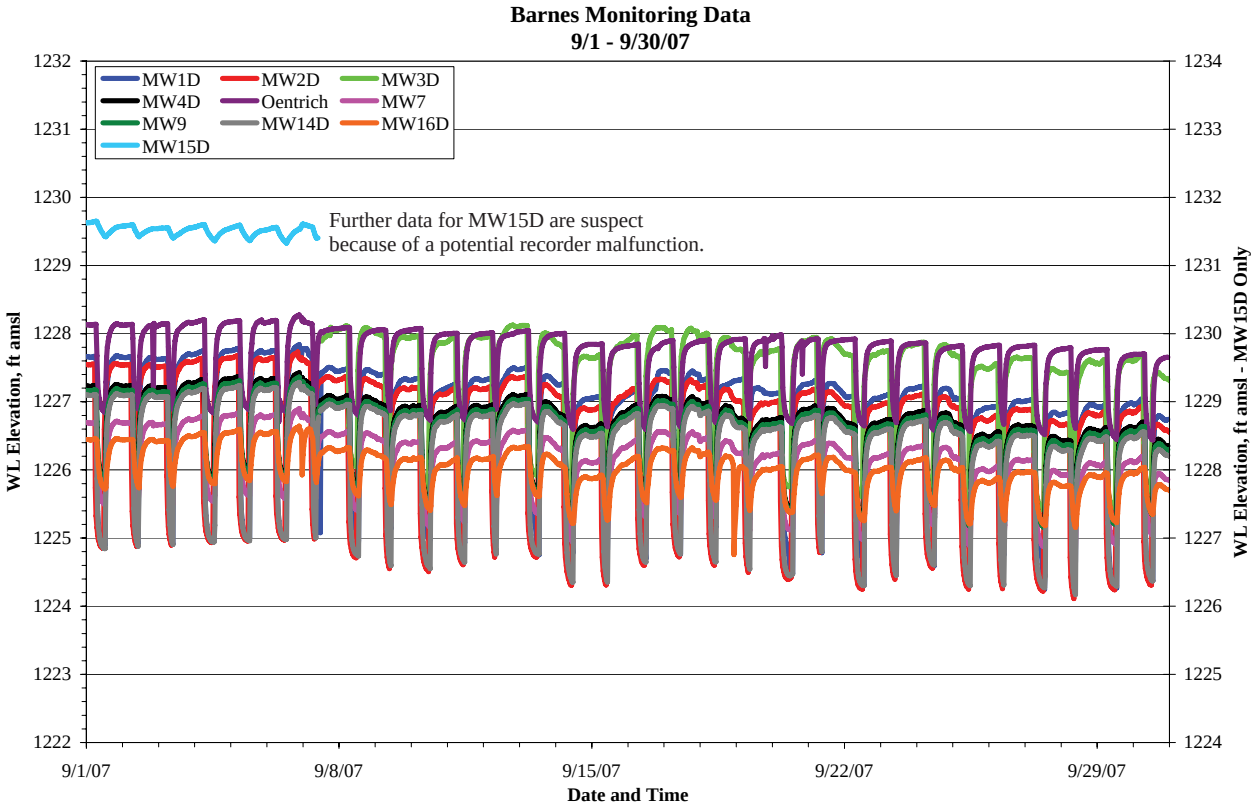


FIGURE 3.1 (Cont.)



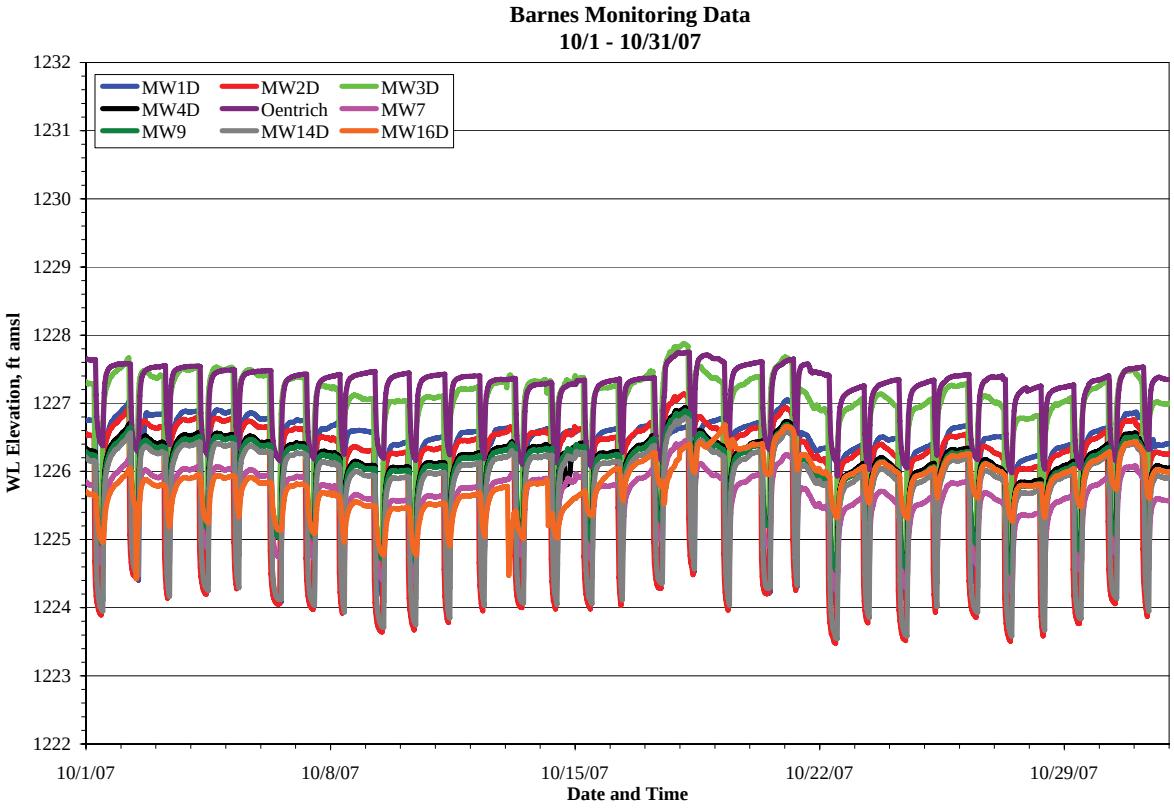


FIGURE 3.1 (Cont.)

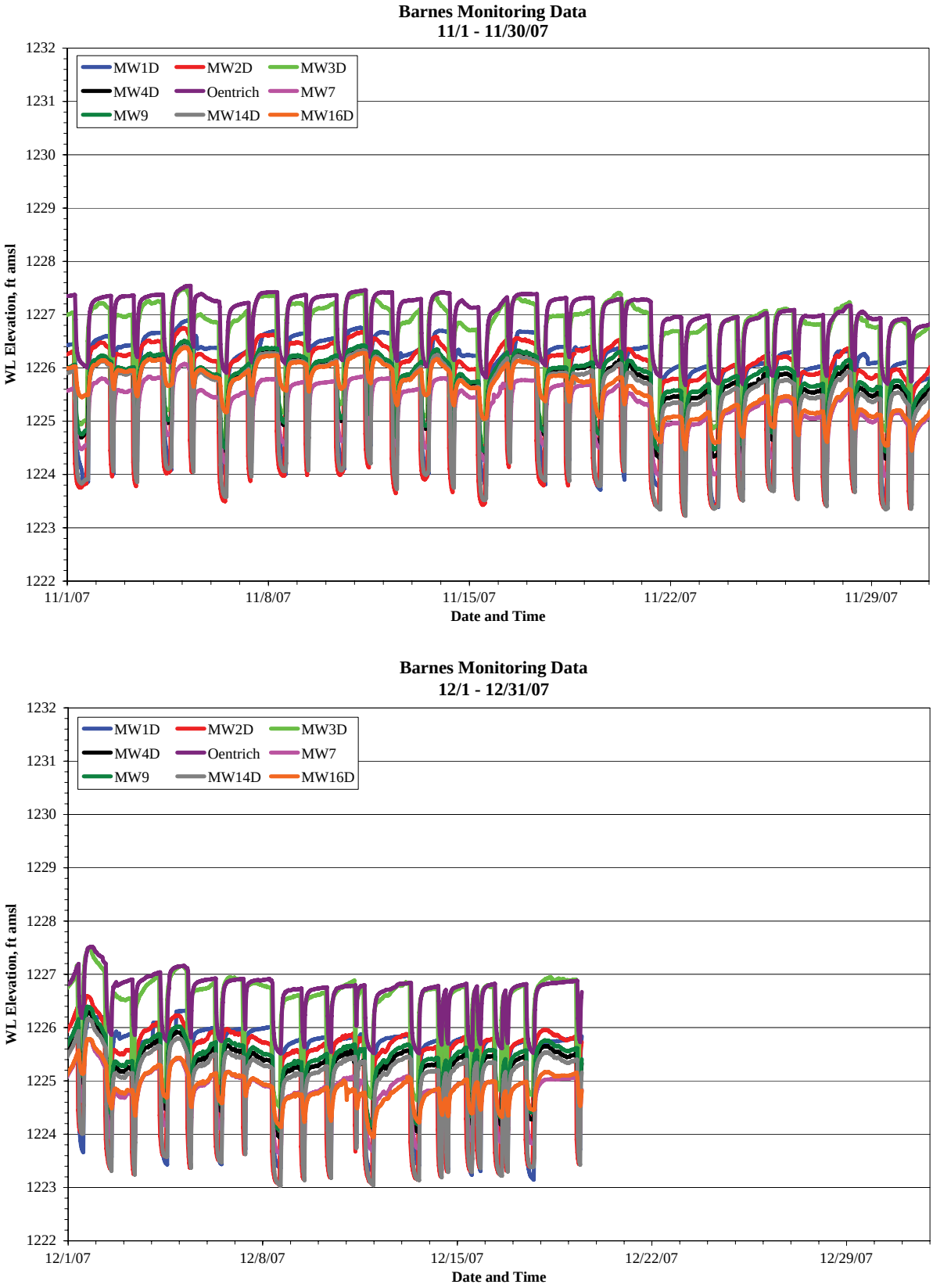


FIGURE 3.1 (Cont.)

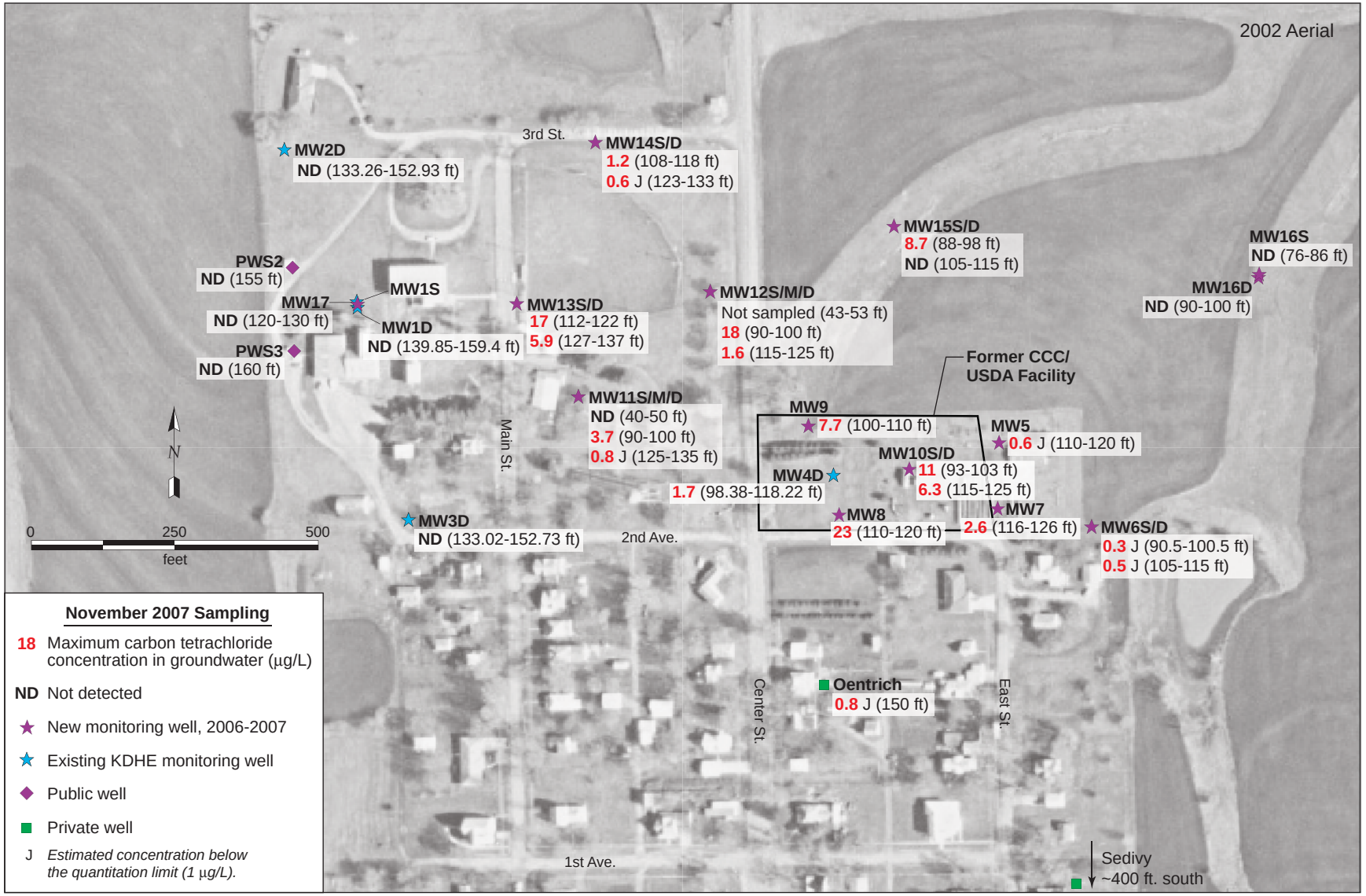


FIGURE 3.2 Analytical results for carbon tetrachloride in groundwater samples collected at Barnes in November 2007.

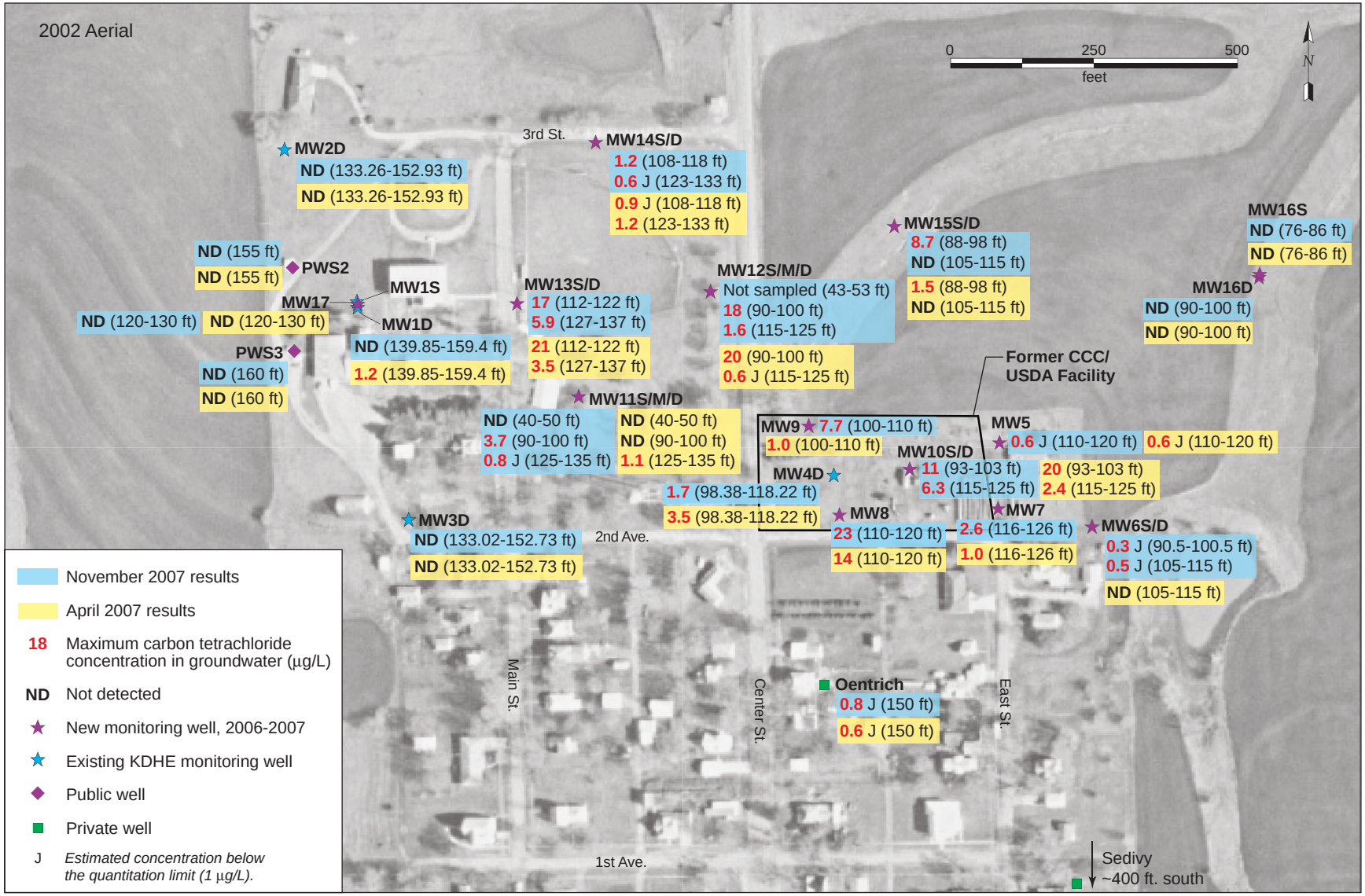


FIGURE 3.3 Analytical results for carbon tetrachloride in groundwater samples collected at Barnes in November 2007 and April 2007.

4 Conclusions and Recommendations

4.1 Conclusions

The findings of the November 2007 monitoring event at Barnes support the following conclusions:

- Measurements of groundwater levels obtained manually and through the use of automatic recorders have consistently indicated that the flow direction is strongly influenced by pumping of the public water supply wells. The results continue to indicate the following:

  - An apparently radial, relatively weak groundwater flow pattern to the northwest and east-southeast from an area southwest of the former CCC/USDA facility when the public wells *are not pumping* and

  - A strong northwest flow direction, with an increased gradient, when the public wells *are pumping*. The observed frequency of the public well operation suggests that this northwest flow likely represents the dominant trend influencing the movement of groundwater, and carbon tetrachloride migration, at the site.

- The November 2007 analytical data for groundwater samples are generally consistent with previous results. The data show only minor increases or decreases in contaminant levels at various locations relative to the April 2007 sampling event. The changes are insignificant and fall within the variability expected between sampling events.

4.2 Recommendations

The report for the 2006-2007 targeted investigation (Argonne 2007) has been submitted to the KDHE for review. Upon completion of the KDHE review, the CCC/USDA and Argonne will address all comments. With the KDHE's approval, the next phase of work at Barnes

(quarterly monitoring) will continue to be implemented as recommended in the targeted investigation report (Argonne 2007).

5 References

Argonne, 2002, *Final Master Work Plan: Environmental Investigations at Former CCC/USDA Facilities in Kansas, 2002 Revision*, ANL/ER/TR-02/2004, prepared for the Commodity Credit Corporation, U.S. Department of Agriculture, Washington, D.C., by Argonne National Laboratory, Argonne, Illinois, December.

Argonne, 2007, *Draft Report: Results of the 2007-2007 Investigation of Potential Contamination at the Former CCC/USDA facility in Barnes, Kansas*, ANL/EVS/AGEM/TR-07-12, prepared for the Commodity Credit Corporation, U.S. Department of Agriculture, Washington, D.C., by Argonne National Laboratory, Argonne, Illinois, October.

EPA, 1995, *Method 524.2: Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry, Revision 4.1*, edited by J.W. Munch, National Exposure Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio.

Sabetha, 2007, *General Receipt #34699* Office of City Clerk, City of Sabetha, Kansas, acknowledging receipt of $50 from Argonne National Laboratory "for purged water," December 14.

Appendix A:

Sampling Activities and Field Measurements at Barnes in November 2007

TABLE A.1 Sequence of sampling activities during the November 2007 monitoring event at Barnes, Kansas.

Sample Date	Time	Location	Sample	Medium	Type	Depth (ft TOC)[a]	Chain of Custody	Shipping Date	Sample Description
11/18/07	13:15	MW12S	BAMW12S-dry	Water	MW	13.3-23.3	–	–	Well dry.
11/18/07	13:30	MW12D	BAMW12D-W-22610	Water	MW	115-125	3575	11/19/07	Static water level from top of casing (TOC) prior to sampling = 102.00 ft. Depth of well = 124.7 ft. Sample collected at low flow after purging of 11.5 gal with Redi-Flo pump. Quick recharge.
11/18/07	13:31	MW12D	BAMW12D-W-22610FD	Water	MW	115-125	3575	11/19/07	Replicate of sample BAMW12D-W-22610.
11/18/07	14:55	MW14S	BAMW14S-W-22613	Water	MW	108-118	3575	11/19/07	Static water level from TOC prior to sampling = 106.75 ft. Depth of well = 117.5 ft. Sample collected at low flow after purging of 6.50 gal with Redi-Flo pump. Quick recharge.
11/18/07	14:56	MW14S	BAMW14S-W-22613FD	Water	MW	108-118	3575	11/19/07	Replicate of sample BAMW14S-W-22613.
11/18/07	15:38	MW14D	BAMW14D-W-22614	Water	MW	123-133	3575	11/19/07	Static water level from TOC prior to sampling = 107.10 ft. Depth of well = 133.3 ft. Sample collected at low flow after purging of 13.5 gal with Redi-Flo pump. Quick recharge.
11/18/07	15:39	MW14D	BAMW14D-W-22614FD	Water	MW	123-133	3575	11/19/07	Replicate of sample BAMW14D-W-22614.
11/18/07	16:00	MW15D	BAMW15D-W-22616	Water	MW	105-115	3575	11/19/07	Static water level from TOC prior to sampling = 70.20 ft. Depth of well = 117.30 ft. Sample collected at low flow after purging of 24 gal with Redi-Flo pump. Quick recharge.
11/18/07	16:40	MW1D	BAMW1D-W-22593	Water	MW	139.85-159.4	3575	11/19/07	Static water level from TOC prior to sampling = 124.89 ft. Depth of well = 156.28 ft. Sample collected at low flow after purging of 16 gal with Redi-Flo pump. Quick recharge with minimal drawdown.
11/18/07	16:45	MW1S	BAMW1S-dry	Water	MW	13.3-23.3	–	–	Well dry.
11/18/07	17:10	MW2D	BAMW2D-W-22594	Water	MW	133.26-152.93	3575	11/19/07	Static water level from TOC prior to sampling = 122.56 ft. Depth of well = 155.0 ft. Sample collected at low flow after purging of 16.75 gal with Redi-Flo pump. Quick recharge with minimal drawdown.
11/18/07	17:37	MW15S	BAMW15S-W-22615	Water	MW	88-98	3575	11/19/07	Static water level from TOC prior to sampling = 84.33 ft. Depth of well = 96.0 ft. Sample collected at low flow after purging of 6.25 gal with Redi-Flo pump. Quick recharge.
11/18/07	18:00	QC	BAQCTB-W-22625	Water	TB	–	4777	11/20/07	Trip blank sent to Envirosystems, Inc., for verification organic analysis with three water samples listed on chain-of-custody (COC) form 4777. The samples (BAMW12D-W-22610, BAMW14S-W-22613, BAMW14D-W-22614) were received by the laboratory but were not analyzed.
11/18/07	20:30	QC	BAQCTB-W-22623	Water	TB	–	3575	11/19/07	Trip blank sent to the AGEM Laboratory for organic analyses with water samples listed on COCs 3575, 3573, and 3572.
11/19/07	8:02	MW17	BAMW17D-W-22619	Water	MW	120-130	3572	11/19/07	Static water level from TOC prior to sampling = 102.68 ft. Depth of well = 132.0 ft. Sample collected at low flow after purging of 15.5 gal with Redi-Flo pump. Quick recharge.
11/19/07	8:55	MW4D	BAMW4D-W-22596	Water	MW	98.38-118.22	3573	11/19/07	Static water level from TOC prior to sampling = 101.39 ft. Depth of well = 115.4 ft. Sample collected at low flow after purging of 7.5 gal with Redi-Flo pump. Quick recharge.

TABLE A.1 (Cont.)

Sample Date	Time	Location	Sample	Medium	Type	Depth (ft TOC)[a]	Chain of Custody	Shipping Date	Sample Description
11/19/07	9:00	MW3D	BAMW3D-W-22595	Water	MW	133.02-152.73	3573	11/19/07	Static water level from TOC prior to sampling = 126.25 ft. Depth of well = 157.00 ft. Sample collected at low flow after purging of 15.5 gal with Redi-Flo pump. Quick recharge.
11/19/07	9:15	MW5	BAMW5-W-22597	Water	MW	110-120	3573	11/19/07	Static water level from TOC prior to sampling = 102.78 ft. Depth of well = 120.0 ft. Sample collected at low flow after purging of 9.25 gal with Redi-Flo pump. Quick recharge.
11/19/07	9:30	MW6S	BAMW6S-W-22598	Water	MW	90.5-100.5	3573	11/19/07	Static water level from TOC prior to sampling = 96.10 ft. Depth of well = 102.44 ft. Sample collected at low flow after purging of 4.5 gal with Redi-Flo pump. Slow recharge.
11/19/07	9:35	MW6D	BAMW6D-W-22599	Water	MW	105-115	3573	11/19/07	Static water level from TOC prior to sampling = 98.50 ft. Depth of well = 117.4 ft. Sample collected at low flow after purging of 5 gal with Redi-Flo pump. Slow recharge.
11/19/07	9:40	MW16S	BAMW16S-W-22617	Water	MW	76-86	3572	11/19/07	Static water level from TOC prior to sampling = 75.30 ft. Depth of well = 83.4 ft. Sample collected at low flow after purging of 4.5 gal with Redi-Flo pump. Slow recharge.
11/19/07	9:45	MW16D	BAMW16D-W-22618	Water	MW	90-100	3572	11/19/07	Static water level from TOC prior to sampling = 74.50 ft. Depth of well = 101.30 ft. Sample collected at low flow after purging of 13.75 gal with Redi-Flo pump. Slower recharge.
11/19/07	10:40	MW8	BAMW8-W-22601	Water	MW	110-120	3573	11/19/07	Static water level from TOC prior to sampling = 105.17 ft. Depth of well = 119.0 ft. Sample collected at low flow after purging of 7 gal with Redi-Flo pump. Quick recharge.
11/19/07	11:30	MW11S	BAMW11S-W-22605	Water	MW	40-50	3573	11/19/07	Static water level from TOC prior to sampling = 29.20 ft. Depth of well = 49.80 ft. Sample collected at low flow after purging of 3.5 gal with Redi-Flo pump. Quick recharge.
11/19/07	11:35	MW11M	BAMW11M-W-22606	Water	MW	90-100	3573	11/19/07	Static water level from TOC prior to sampling = 82.33 ft. Depth of well = 102.0 ft. Sample collected at low flow after purging of 10.5 gal with Redi-Flo pump. Quick recharge.
11/19/07	12:00	MW11D	BAMW11D-W-22607	Water	MW	125-135	3573	11/19/07	Static water level from TOC prior to sampling = 112.46 ft. Depth of well = 135.3 ft. Sample collected at low flow after purging of 11.75 gal with Redi-Flo pump. Quick recharge.
11/19/07	12:10	Oentrich	BAOENTRICH-W-22622	Water	DW	150	3573	11/19/07	Unable to access well head. Depth of well approximately 150 ft. Sample collected after pump had run for about 10 min.
11/19/07	12:50	MW13D	BAMW13D-W-22612	Water	MW	127-137	3572	11/19/07	Static water level from TOC prior to sampling = 117.83 ft. Depth of well = 136.2 ft. Sample collected at low flow after purging of 9.5 gal with Redi-Flo pump. Quick recharge.
11/19/07	13:05	MW9	BAMW9-W-22602	Water	MW	100-110	3573	11/19/07	Static water level from TOC prior to sampling = 97.20 ft. Depth of well = 115.25 ft. Sample collected at low flow after purging of 9.25 gal with Redi-Flo pump. Quick recharge.
11/19/07	13:10	MW7	BAMW7-W-22600	Water	MW	116-126	3573	11/19/07	Static water level from TOC prior to sampling = 105.5 ft. Depth of well = 125.5 ft. Sample collected at low flow after purging of 10 gal with Redi-Flo pump. Quick recharge.

TABLE A.1 (Cont.)

Sample Date	Time	Location	Sample	Medium	Type	Depth (ft TOC)[a]	Chain of Custody	Shipping Date	Sample Description
11/19/07	14:00	MW13S	BAMW13S-W-22611	Water	MW	112-122	3572	11/19/07	Static water level from TOC prior to sampling = 92.23 ft. Depth of well = 122.3 ft. Sample collected at low flow after purging of 15.5 gal with Redi-Flo pump. Quick recharge.
11/19/07	14:10	MW12M	BAMW12M-W-22609	Water	MW	90-100	3573	11/19/07	Static water level from TOC prior to sampling = 74.50 ft. Depth of well = 99.0 ft. Sample collected at low flow after purging of 12.5 gal with Redi-Flo pump. Quick recharge.
11/19/07	15:00	MW10S	BAMW10S-W-22603	Water	MW	93-103	3573	11/19/07	Static water level from TOC prior to sampling = 77.81 ft. Depth of well = 104.75 ft. Sample collected at low flow after purging of 13.5 gal with Redi-Flo pump. Quick recharge.
11/19/07	15:05	MW10D	BAMW10D-W-22604	Water	MW	115-125	3573	11/19/07	Static water level from TOC prior to sampling = 106.22 ft. Depth of well = 127.5 ft. Sample collected at low flow after purging of 11.5 gal with Redi-Flo pump. Quick recharge.
11/20/07	8:35	PWS3	BAPW3-W-22621	Water	PW	160	4775	11/20/07	Pump running at time of sampling.
11/20/07	8:45	PWS2	BAPW2-W-22620	Water	PW	155	4775	11/20/07	Pump running at time of sampling.
11/20/07	9:00	QC	BAWW1-W-22626	Water	BT	–	1134204	11/20/07	Waste purge water sample sent to Pace Analytical Services, Inc., for VOCs (including ethylene dibromide) and nitrate analyses, with samples listed on Pace COC 1134204.
11/20/07	16:00	QC	BAQCTB-W-22624	Water	TB	–	4775	11/20/07	Trip blank sent to the AGEM Laboratory for organic analyses with water samples listed on COC 4775.

[a] Depth is in feet below the top of the well casing.

TABLE A.2 Field measurements for groundwater samples collected at Barnes, July 2006 to November 2007.

Well	Screen Interval (ft BGL)	Sample Date	Temperature (°C)	pH	Conductivity (µS/cm)
Existing KDHE monitoring wells					
MW1S	13.3-23.3	7/19/06	– [a]	–	–
		4/4/07	–	–	–
		11/18/07	–	–	–
MW1D	139.85-159.4	7/19/06	22.8	7.15	945
		4/4/07	15.7	6.30	855
		11/18/07	12.7	7.62	712
MW2D	133.26-152-93	7/19/06	24.7	7.72	946
		4/4/07	15.1	6.32	887
		11/18/07	12.1	6.96	1448
MW3D	133.02-152.73	7/19/06	23.0	7.06	976
		4/4/07	15.6	6.37	989
		11/19/07	10.5	7.16	1093
MW4D	98.38-118.22	7/20/06	23.5	6.26	968
		4/6/07	11.3	6.21	1018
		11/19/07	15.7	6.98	1022
CCC/USDA wells installed during the 2006-2007 investigation					
MW5	110-120	4/6/07	13.9	6.17	1705
		11/19/07	15.2	6.74	3070
MW6S	90.5-100.5	4/4/07	–	–	–
		11/19/07	12.0	7.60	723
MW6D	105-115	4/5/07	6.2	6.11	936
		11/19/07	13.6	7.00	1103
MW7	116-126	4/6/07	14.1	6.30	1051
		11/19/07	14.6	7.16	890
MW8	110-120	4/6/07	12.1	6.23	974
		11/19/07	14.6	7.03	909
MW9	100-110	4/5/07	12.9	6.20	976
		11/19/07	16.5	7.21	1066
MW10S	93-103	4/6/07	13.2	6.36	1004
		11/19/07	14.5	7.22	942
MW10D	115-125	4/6/07	12.1	6.21	992
		11/19/07	14.5	7.42	1175
MW11S	40-50	4/4/07	12.8	6.14	1027
		11/19/07	11.2	7.15	1174
MW11M	90-100	4/5/07	7.5	7.60	1097
		11/19/07	11.9	7.17	1144

TABLE A.2 (Cont.)

Well	Screen Interval (ft BGL)	Sample Date	Temperature (°C)	pH	Conductivity (µS/cm)
CCC/USDA wells installed during the 2006-2007 investigation (cont.)					
MW11D	125-135	4/4/07	13.8	6.18	990
		11/19/07	13.1	7.22	987
MW12S	43-53	4/5/07	–	–	–
		11/19/07	–	–	–
MW12M	90-100	4/5/07	12.6	6.42	867
		11/19/07	14.9	7.13	835
MW12D	115-125	4/5/07	14.0	6.36	930
		11/18/07	15.6	6.95	571
MW13S	112-122	4/5/07	9.8	6.42	946
		11/19/07	16.5	7.21	893
MW13D	127-137	4/5/07	14.9	6.25	397
		11/19/07	17.0	7.00	763
MW14S	108-118	4/4/07	13.4	6.50	704
		11/18/07	12.9	7.26	966
MW14D	123-133	4/4/07	14.7	6.34	932
		11/18/07	13.2	7.47	739
MW15S	88-98	4/4/07	13.1	8.03	854
		11/18/07	13.9	–	1883
MW15D	105-115	4/4/07	14.8	6.15	2980
		11/18/07	13.1	6.85	2190
MW16S	76-86	4/4/07	12.8	6.35	1708
		11/19/07	15.0	6.94	1616
MW16D	90-100	4/4/07	14.1	6.17	2910
		11/19/07	12.5	6.78	2400
MW17	120-130	4/4/07	16.0	6.44	861
		11/19/07	8.3	7.15	610
Private wells					
Oentrich	150	7/20/06	–	–	–
		8/2/06	–	–	–
		4/5/07	–	–	–
		11/19/07	12.1	8.26	1830
Sedivy	138	8/22/06	–	–	–
		9/13/06	22.5	6.57	739
Sedivy1	90	9/13/06	–	–	–

TABLE A.2 (Cont.)

Well	Screen Interval (ft BGL)	Sample Date	Temperature (°C)	pH	Conductivity (µS/cm)
Public water supply wells					
PWS2	155	3/9/07	–	–	–
		4/5/07	–	–	–
		11/20/07	–	–	–
PWS3	160	3/9/07	–	–	–
		4/5/07	–	–	–
		11/20/07	–	–	–

[a] Measurement not recorded.

Appendix B:

Sample Documentation from Envirosystems, Inc.

From: Charlie Hampp [mailto:hamppc@comcast.net]

Sent: Wednesday, January 16, 2008 3:08 PM

To: Alvarado, Jorge S.

Cc: Mohan Khare Ph. D.

Subject: Laboratory Error

I am sorry to inform you that the samples listed on the attached chain of custody have not been analyzed. The samples were logged into our LIMS system, but were not processed. The laboratory understands how much a problem the error represents and offers to analyze the original or replacement samples at no cost.

Please let me know what you would like us to do.

Regards,

Charlie Hampp
Director IT & QAO
Envirosystems, Inc.
9200 Rumsey Road, Suite B102
Columbia, MD 21045-1934
410-964-0330 Ext. 225 410-740-9306 (fax)
hamppc@comcast.net

4777

MATRIX: WATER	ARGONNE NATIONAL LABORATORY CHAIN OF CUSTODY RECORD*	Shipping Container No.
RECEIVING LAB: ENVIROSYSTEMS		Shipping Info:
PROJECT/SITE: BARNES	ANALYSIS	ANL Field Contact (Name & Temporary Phone):
SAMPLER(S) (Signature)		

DATE OF COLLECTION	SAMPLE ID NUMBER(S)	Number of containers	VOC										REMARKS
11.18.07	BAMW120-W-22610	4	X										
	BAMW145-W-22613	4	X										
	BAMW140-W-22614	4	X										
	BAQCTB-W-22625	1	X										

Relinquished by (Signature)	Date	Time	Received by (Signature)	Relinquished by (Signature)	Date	Time	Received by (Signature)
	11.20.07	1800			11/21/07	10:40 a.m.	
Relinquished by (Signature)	Date	Time	Received for Laboratory by	Date	Time	Remarks: Cooler 2°C	

Y	N	FOR LAB USE ONLY
		Custody seal was intact when shipment received.
		Sample containers were intact when received.
		Shipment was at required temperature when received.
		Sample labels, Tags and COC agree.

*A sample is under custody if:
1. It is in your possession; or,
2. It is in your view, after having been in your possession; or,
3. It was in your possession and you locked it up; or,
4. It is in a designated secure area.

Argonne National Laboratory, Applied Geosciences & Environmental Mgt. Group, Environmental Research Division, 9700 S. Cass Avenue, Argonne, IL 60439

Appendix C:

Results from the AGEM Laboratory for Dual Analyses of Samples Collected at Barnes in November 2007

TABLE C.1 Analytical results for samples and replicates collected at Barnes in November 2007.

Location	Screen Interval (ft BGL)	Sampling Date	Sample	Sample Type	EPA Analytical Method	Laboratory	Concentration (µg/L)		
							Carbon Tetrachloride	Chloroform	Methylene Chloride
MW12D	115-125	11/18/07	BAMW12D-W-22610	Primary	524.2	AGEM	1.6	ND[a]	ND
			BAMW12D-W-22610FD	Replicate	524.2	AGEM	1.8	ND	ND
			BAMW12D-W-22610	Verification	SW8260	ESIC[b]	NA[c]	NA	NA
MW14D	123-133	11/18/07	BAMW14D-W-22614	Primary	524.2	AGEM	0.6 J[d]	ND	ND
			BAMW14D-W-22614FD	Replicate	524.2	AGEM	0.4 J	ND	ND
			BAMW14D-W-22614	Verification	SW8260	ESIC	NA	NA	NA
MW14S	108-118	11/18/07	BAMW14S-W-22613	Primary	524.2	AGEM	1.2	ND	ND
			BAMW14S-W-22613FD	Replicate	524.2	AGEM	1.2	ND	ND
			BAMW14S-W-22613	Verification	SW8260	ESIC	NA	NA	NA

[a] ND, not detected at an instrument detection limit of 0.1 µg/L.

[b] ESIC, Envirosystems, Inc.

[c] NA, not analyzed.

[d] Qualifier J indicates an estimated concentration below the method quantitation limit of 1.0 µg/L.

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